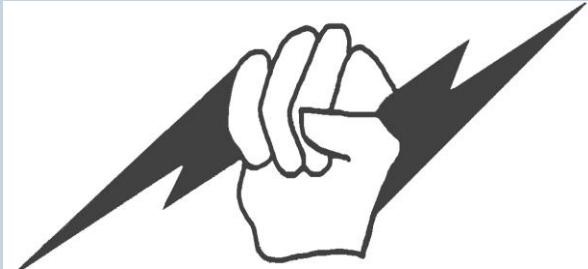


Helwan University
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A Course on

Energy Conservation

Waste Heat Recovery

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Introduction

The quality of heat is not the amount but rather its “value”.

The strategy depends on **T.**



Introduction

Large quantity of hot flue gases is generated from Boilers, Ovens and Furnaces.

The energy lost in waste gases cannot be fully recovered.



Heat Losses – Quantity

It is essential to:

1- Know the amount of heat recoverable.

- Temperature**
- Quantity**

2- Know how it can be used.

Heat Losses – Quantity

WASTE SOURCE AND QUALITY		
	Source	Quality
1.	Heat in flue gases.	The higher the temperature, the greater the value for heat recovery.
2.	Heat in vapour streams.	As above but when condensed, latent heat also recoverable.
3	Convective and radiant heat lost from exterior of equipment.	Low grade – if collected may be used for space heating or air preheats.
4.	Heat losses in cooling water.	Low grade
5.	Heat stored in products leaving the process.	Quality depends upon temperature.
6.	Heat in gaseous and liquid effluents leaving process.	Poor if heavily contaminated



High Temperature Heat Recovery

TYPICAL WASTE HEAT FROM VARIOUS SOURCES	
Types of Device	°C
Nickel refining furnace	1370 –1650
Aluminium refining furnace	650-760
Zinc refining furnace	760-1100
Copper refining furnace	760- 815
Steel heating furnaces	925-1050
Copper reverberatory furnace	900-1100
Open hearth furnace	650-700
Cement kiln (Dry process)	620- 730
Glass melting furnace	1000-1550
Hydrogen plants	650-1000
Solid waste incinerators	650-1000
Fume incinerators	650-1450

Medium Temperature Heat Recovery

TYPICAL WASTE HEAT FROM VARIOUS SOURCES	
Type of Device	°C
Steam boiler exhausts	230-480
Gas turbine exhausts	370-540
Reciprocating engine exhausts	315-600
Turbocharged engine	230- 370
Heat treating furnaces	425 - 650
Drying and baking ovens	230 - 600
Catalytic crackers	425 - 650
Annealing furnace	425 - 650



Low Temperature Heat Recovery

TYPICAL WASTE HEAT FROM VARIOUS SOURCES	
Source	°C
Process steam condensate	55-88
Cooling water from:	
Furnace doors	32-55
Welding machines	32-88
Injection molding machines	32-88
Annealing furnaces	66-230
Forming dies	27-88
Air compressors	27-50
Pumps	27-88
Internal combustion engines	66-120
Air conditioning and refrigeration condensers	32-43
Drying, baking and curing ovens	93-230
Hot processed liquids	32-232
Hot processed solids	93-232

Benefits of Waste Heat Recovery

Direct Benefits:

- 1- Efficiency of the process.**
- 2- Reduction in the utility consumption**
- 3-Costs reduction.**



Benefits of Waste Heat Recovery

Indirect Benefits:

- 1- Reduction in pollution.**
- 2- Reduction in equipment sizes ($m^{\circ}_f \downarrow$).**
- 3- Reduction in auxiliary energy consumption.**



Commercial Waste Heat Recovery Devices

1- Recuperator

1- Heat exchange takes place between the flue gases and the air through metallic or ceramic walls.

3- The inner tube carries the hot exhaust gases.

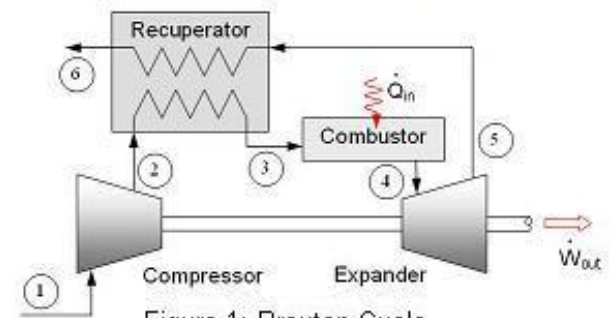
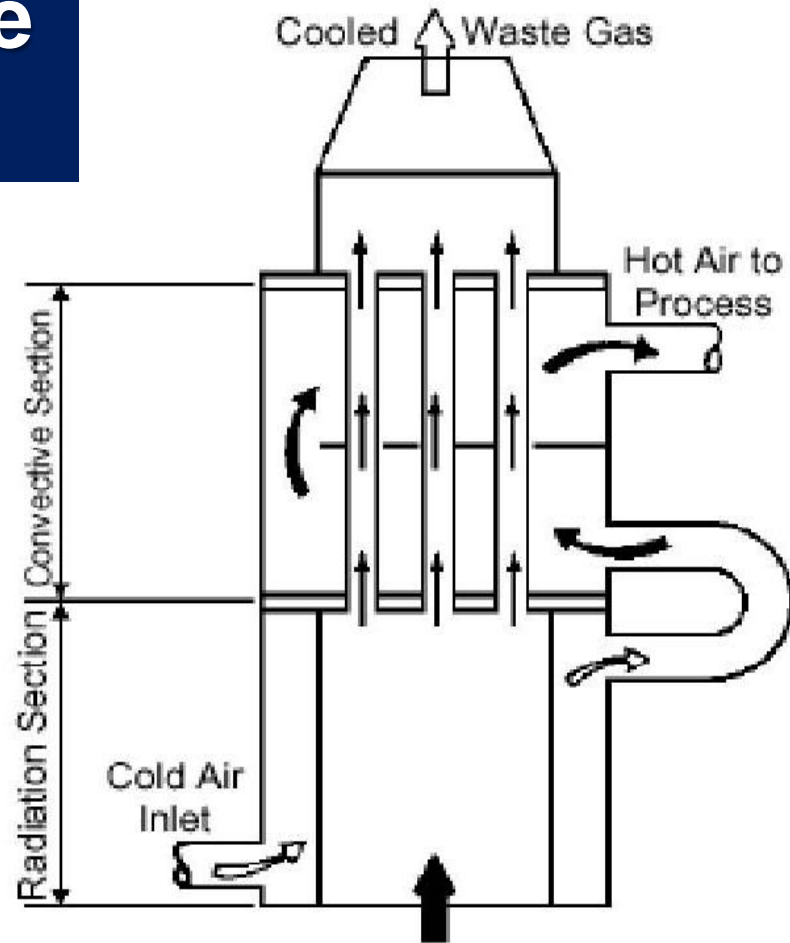


Figure 1: Brayton Cycle

Commercial Waste Heat Recovery Devices₂

2- Radiation/Convective Hybrid Recuperator

- 1- Combinations of radiation and convective designs.
- 2- More expensive than simple metallic radiation recuperators.
- 3- Are less bulky.



Commercial Waste Heat Recovery Devices₃

3- Ceramic Recuperator

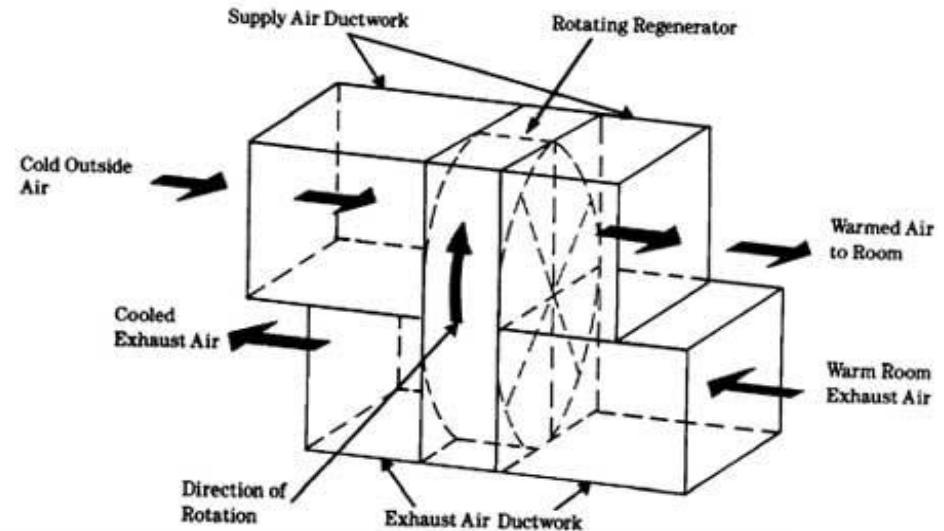
1- Recuperators life time ↓ if $T \uparrow 1100^{\circ}\text{C}$.

2- Ceramic tube recuperators up to 1550°C .



Commercial Waste Heat Recovery Devices₅

5- Heat Wheels



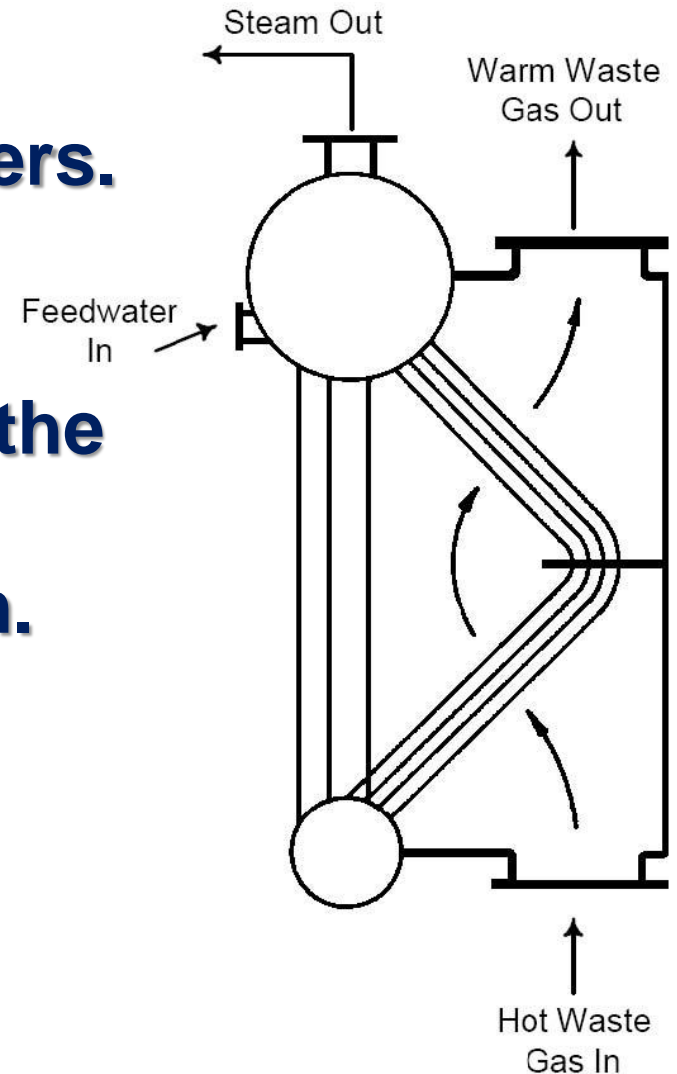
- 1- Low to medium temperature systems.
- 2- Sizable disk having a high heat capacity.
- 3- Rotates between cold and hot gas ducts.
- 4- Heat is transferred from hot to cold air.
- 5- The overall efficiency is up to 85 %.
- 6- Have been built as large as 21 m.

Applications in Industries

- **Preheating of boiler combustion air.**
- **Reheating of fresh air for hot air driers.**
- **Reuse as heat source for other ovens.**
- **Cooling of closed rooms with outside air.**
- **Preheating of boiler feed water (economizers).**
- **Drying, curing and baking ovens**
- **HVAC systems.**
- **Etc.**

Waste Heat Boilers

- 1- Ordinarily water tube boilers.
- 2- From gas turbines, incinerators, etc.
- 3- The water is vaporized in the tubes.
- 4- Collected in a steam drum.
- 5- It is used for heating or processing steam.



Thank you

**Any
questions**



Solve this problem (Time 5 minutes)

Estimate the expected drinking water (m^3/hr) generated by implementing a cogeneration system in a diesel generator as shown.

